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(54) TRANSVERSE DISCHARGE PUMPING TYPE PULSE LASER.

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Description

The present invention relates to a transverse discharging excitation pulse laser oscillator apparatus including electron affinity gas, in particular relates to the constitution of its pre-ionization electrodes.

FIG.5 is a cross-sectional drawing showing a discharging electrode of a conventional transverse discharge excitation pulse laser oscillator apparatus shown for example in T.S.Fahlen, "High Average Power Excimer Laser", United States Energy Research and Development Administration, DOE/SF/90024-T2 (1977) wherein: (1) is a first main electrode; (1a) is a 6.3 mm (1/4 inch) outer diameter tube which constitutes a tip part of the main electrode (1); (2) is a second main electrode; (3) is a main discharge which is produced between main electrodes (1) and (2); (4) is an auxiliary electrode comprised of a wire disposed in the vicinity of the first main electrode (1); (5) is a dielectric material pipe comprised of quartz pipe of approximately 5 mm outer diameter which is disposed in a manner that it contains the auxiliary electrode (4) inside and touches with the first main electrode (1); (6a) and (6b) are corona discharges taking place on the surface of the dielectric material pipe; and (7a) and (7b) are corona discharge starting points.

Next, explanation is given on its action. First, upon applying a voltage across the first main electrode (1) and the auxiliary electrode (4), corona discharges (6a) and (6b) start from points (7a) and (7b) at which the dielectric material (5) and the first main electrode (1) touch to each other in a manner that they cover the dielectric material pipe (5). Ultra-violet radiation is radiated from these corona discharges (6a) and (6b), thereby laser gas between the main electrodes (1) and (2) is pre-ionized. Subsequently, when a voltage is applied across the main electrodes (1) and (2), the pre-ionized gas starts to discharge and then the main discharge (3) takes place. The laser gas is excited by this main discharge (3), thereby the laser starts to oscillate in a direction which is perpendicular with respect to the plane of sheet. In the conventional transverse discharge excitation pulse laser oscillator apparatus as described above, there has been a problem that the ultra-violet radiation generated in the vicinity of the corona discharge starting points (7a) and (7b), where light emission caused by the corona discharge is strong, was not radiated efficiently into the space between the main discharge electrodes (1) and (2).

US-A-3 740 662 discloses a gas laser discharge tube in which at least one portion of the main cathode has at least one sharp protruberance, and having at least one auxiliary electrode arranged in the vicinity of the end of this sharp protruberance and separated therefrom by a solid insulator.

According to the present invention a pulse laser oscillator apparatus is provided as defined in claim 1.

Embodiments are given in claims 2 to 7. The intensity of the ultraviolet radiation can be made strong. In addition, by providing a configuration through which this ultra-violet radiation can be illuminated efficiently into the space between the main electrodes, a uniform discharge can be realized even in the case that a strong electron affinity gas such as F_2 gas is included in the laser gas. Thus, a transverse discharge excitation pulse laser oscillator apparatus is obtained which can oscillate with a high efficiency.

By extending the length of the corona discharge, a pre-ionized discharge is constituted in a manner that a strong part of the corona discharge is directed toward the space between the main electrodes. Owing to such the constitution, also by making the extension length of the corona discharge long, the amount of the ultra-violet radiation is enhanced. The electrodes are disposed in a manner that the ultra-violet radiation produced in the vicinity of the corona discharge starting point at which the light-emission amount is strong can radiate into the space between the main electrodes.

FIG.1 is a side cross-sectional view showing a transverse discharge excitation pulse laser oscillator apparatus in accordance with one embodiment of the present invention. FIG.2 is a side cross-sectional view of a corona discharge part for explaining a corona discharge extension length. FIG.3 and FIG.4 are side cross-sectional views of transverse discharge excitation pulse laser oscillator apparatus showing other embodiments of the present invention. FIG.5 is a side cross-sectional view of a transverse discharge excitation pulse laser oscillator apparatus of prior art.

In the following, explanation is given on one embodiment of the present invention referring to drawings. FIG.1 is a cross-sectional view in a plane perpendicular with respect to the laser oscillation optical axis of a transverse discharge excitation pulse laser oscillator apparatus, and in the drawing, (4a) and (4b) are auxiliary electrodes of cylindrical shape which are disposed at a distance on both sides of a second main electrode (2). (5a) and (5b) are dielectric material pipes having almost the same inner diameter as an outer diameter of the auxiliary electrodes (4a) and (4b), and in this case, they are made of alumina ceramics composed of alumina as its main composition. (8a) and (8b) are corona starting electrodes which are wire-shaped conductors disposed at positions near the second main electrode (2) along the outer peripheries of the dielectric material pipes (5a) and (5b) in a manner that they are kept at the same potential as that of the second main electrode (2). Further, (6a), (6b), (6c), and (6d) are corona discharges and (7a), (7b), (7c), and (7d) are corona discharge starting points at which the corona discharges (6a), (6b), (6c), and (6d) start (9) is a center point of the electrode surface of the first main electrode (1) which is facing to the second main electrode (2). A first direction (10) is

determined by a straight line connecting between the corona starting point (7c) and the center point (9). A second direction (11) is a straight line obtained by an intersection of a plane which is perpendicular with respect to an extending direction of the corona discharge (6a) on the periphery of the corona starting electrode (8b) and a plane which is perpendicular with respect to a laser oscillation optical axis.

Upon applying a voltage across the second main electrode (2) and the auxiliary electrodes (4a) and (4b), an electrical field concentration takes place in the vicinity of the corona starting electrodes (8a) and (8b) which are connected in a manner that they keep the same potential as that of the second main electrode (2). Corona discharge starts first at those parts of (7a), (7b), (7c), and (7d) at which the corona starting electrodes (8a) and (8b) are close to the dielectric material pipes (5a) and (5b). The constitution of this drawing corresponds to a case of the surface-propagating corona discharge. In the presence of electrodes in the back surface, the corona discharges start from the corona discharge starting points (7a), (7b), (7c), and (7d) develop along the surface of the dielectric material pipes (5a) and (5b) to form corona discharges (6a), (6b), (6c), and (6d). The extension length of the corona discharge (6a) is indicated by a notation ℓ. The extension length ℓ of the corona discharge equals approximately half of the outer circumferential length of the dielectric material pipe (5) in this case.

In FIG.2, various shapes of the corona discharges as well as the corona discharge extension lengths thereof are shown. FIG.2(a) shows a case with two corona starting electrodes (8a) and (8b) disposed on the surface of the dielectric material pipe (5) composed of cylindrical pipe. FIG.2(b) shows a case with four corona starting electrodes (8a), (8b), (8c), and (8d) disposed on the surface of the dielectric material pipe (5) composed of cylindrical pipe. FIG.2(c) shows a case with one corona starting electrode (8) disposed on the surface of the dielectric material pipe (5) composed of square-shaped pipe. FIG.2(d) shows a case with a corona starting electrode (8) wound spirally on the surface of the dielectric material pipe (5) composed of cylindrical pipe. In FIG.1 and FIG.2(a), (b), and (c), the corona starting electrodes are electrodes extending in the direction perpendicular with respect to the plane of sheet. In the cases of FIG.1 and FIG.2(c) with only one corona starting electrode (8) present on the periphery of the dielectric material pipe (5), the extension length ℓ of the corona discharge equals approximately to a half of the circumferential length of the dielectric material pipe (5) when it is seen on a cross-section perpendicular to the laser optical axis. On the other hand, as in FIG.2(a), (b), and (d), where corona starting electrodes (8) are disposed with a constant pitch on the periphery of the dielectric material pipe (5), the extension length ℓ of the corona discharge equals approximately half of this pitch. The light-emission amount from the corona discharge was measured on various shaped electrodes and it has been found that, as far as the outer shape of the dielectric material pipe (5) was the same, configurations of FIG.1 and FIG.2(c) gave the greatest amount of light emission. For example, in the case of FIG.2(a) in which the corona discharge extension length becomes half comparing with FIG.1, the amount of ultra-violet radiation also becomes half. And, in the case of FIG.2(b) in which the corona discharge extension length becomes 1/4 compared with FIG.1, the amount of ultra-violet radiation diminishes to 1/4. Thus, in spite of covering almost the entire surface of the dielectric material pipe (5) with the corona discharge (6), an electrode configuration having a longer corona discharge extension length gave more emission of ultra-violet radiation. In addition to that, the emission amount of ultra-violet radiation was proportional to the extension length ℓ of the corona discharge. Precise measurements of the emission amount of the ultra-violet radiation from the corona discharge (6) revealed that the emission intensity was great in the vicinity of corona discharge starting points (7) and it diminished as proceeding up to the tip of the corona discharge (6).

From the result described above, it was revealed that by making the extension length ℓ of the corona discharge longer and disposing the corona discharge starting points (7) in a manner that they face to the location at which the main discharge (3) takes place, the amount of the pre-ionization could be increased. Furthermore since the ultra-violet radiation propagates in the gas space while it is diverging and is absorbed by gas on its way of propagation, a closer disposition of the occurrence points of the corona discharges (6) to the main electrodes (1) and (2) can increase the amount of the pre-ionization. However, since an excessive proximity of the dielectric material pipes (5) to the first main electrode (1) eventually introduces a discharge between the first main electrode (1) and the corona starting electrodes (8), it is necessary to separate them by keeping at more than a certain distance. Since the first main electrode (1) is disposed at a more distant point from the corona discharge (6) more the second main electrode (2), it is desirable to select a position at which the ultra-violet radiation is efficiently illuminated on the main electrode (1). That is, in FIG.1, since the ultra-violet radiation of strong intensity emitted in the vicinity of the corona discharge starting points (7) is strongly radiated in a second direction (11), at a time when this second direction (11) coincides with the first direction (10), the amount of the pre-ionization becomes largest. Denoting the angle between the first direction (10) and the second direction (11) to be θ, the amount of the pre-ionization becomes proportional to $\cos\theta$.

Actual experiments using an excimer laser in-

cluding fluorine gas at gap lengths g = 10 - 30 mm showed that;

laser oscillations with a comparatively high efficiency could be obtained, if,

(1) when $\theta = 0 - 72.5$ degrees,

I is such that, $I = \ell \times \cos\theta = 3$ mm or more,

(2) and when θ = more than 72.5 degrees (in case that the corona discharge starting point (7) is hidden back side),

I is such that, $I = \ell \times 0.3 = 3$ mm or more.

In the above equations, parameter I is a quantity expressing the strength of the pre-ionization. If I = 5 mm or more, the laser oscillation efficiency increases further (3 % or more). In a case that the corona discharge (6) is carried out at only one side of the main discharge (2) as is shown in FIG.1, it is necessary to take a value of the parameter I to be twice the above-mentioned value.

It was also found that, when the minimum separation distance L (14) between the first main electrode (1) and the dielectric material pipes (5) is taken to be 1.05 times or more and 1.5 times or less of the minimum gap length g between the first main electrode (1) and the second main electrode (2), the laser oscillates in a good efficiency. Moreover no arc discharge takes place between the first main electrode (1) and the dielectric material pipes (5). In FIG.1, the minimum separation distance L (14) between the first main electrode (1) and the dielectric material pipes (5) is taken to be 1.17 times of the minimum gap length g.

FIG.3 is a side cross-sectional view showing other embodiment of the present invention. The dielectric material pipes (5) are disposed in such a manner as they are buried in on both sides of the center part of the second main electrode (2). The corona starting electrodes (8) take a unitary construction with the second main electrode (2). By taking this construction, the corona starting electrodes (8) can be omitted and the configuration becomes simple. Also, in case that a gas flow (12) between the main electrodes (1) and (2), it becomes possible to let the gas flow in a high speed since there is no obstacle impeding against the gas flow. Therefore, it is convenient to operate the laser in a high repetition rate mode.

FIG.4 is a side cross-sectional view showing another embodiment of the present invention. The dielectric material pipes (5a) and (5b) are disposed in such a manner as they are buried in the second main electrode (2). At the same time the dielectric material pipes (5a) and (5b) are allowed to float so that they can keep a distance d or more from the electrode (2) except that they come close thereto or they make contact with the second main electrode (2) at its parts (13a) and (13b). If the distance d is larger than the thickness of the dielectric material pipe (5), the corona discharge (6) is extended on its extension length as is shown in FIG.4, thereby the pre-ionization amount can be increased. And, since the dielectric material pipes (5) are disposed in the second main electrode, they cannot be an obstacle to the gas flow (12) and hence the gas can be circulated with a high speed. Hence a high repetition rate operation of the laser becomes possible.

Although, in FIG.1, Fig.2 (a), (b), and (c), the corona starting electrodes (8) have a uniform shape in the laser optical axis direction, a non-uniform shape, for example, having projections sporadically along the laser optical axis can also exhibit the same effect.

Although explanation has been given using an alumina ceramics containing alumina as its main composition as for the dielectric material for an excimer laser, certain other materials can also exhibit the same effect for different lasers.

As has been described above, according to the present invention, owing to the lengthening of the extension length of the corona discharge and the pre-ionization by ultra-violet radiation emitted from a strong part of the corona discharge, a uniform main discharge can be obtained and thereby the laser oscillation efficiency becomes high.

Claims

1. A transverse discharge excitation pulse laser oscillator apparatus provided with a first (1) and a second (2) main electrode which are disposed facing each other over a specified length in the laser optical axis direction, said apparatus comprising:

dielectric material hollow pipes (5a, 5b) or pipe (5) extending in the laser optical axis direction and being disposed on both sides or one side of said second main electrode (2) while keeping a distance (d) therefrom,

auxiliary electrodes (4a, 4b) or electrode (4) disposed inside each of said dielectric material pipes or pipe,

corona starting electrodes (8a, 8b, 8c, 8d) or electrode (8) provided in the vicinity of or in contact with said dielectric material pipes (5a, 5b) or pipe (5) and optionally provided as an integral part of said second main electrode (2), the potential of said corona starting electrodes being kept the same as that of the second main electrode (2),

wherein corona discharges (6a, 6b, 6c, 6d) start from said corona starting electrodes (8a, 8b, 8c, 8d) or electrode (8) and develop and extend over the surface of said dielectric material pipes (5a, 5b) or pipe (5) by applying a voltage across said main electrode (2) as well as said corona starting electrodes (8a, 8b, 8c, 8d) or electrode (8) and said auxiliary electrodes (4a, 4b) or electrode (4), wherein laser gas existing between said first and

second main electrodes (1, 2) is preionized by the ultraviolet radiation generated from said corona discharges (6a, 6b, 6c, 6d) thus allowing a uniform main discharge (3) in the space between said first and second main electrodes (1, 2) for exciting the laser gas,
wherein the corona starting electrodes (8a, 8b, 8c, 8d) or electrode (8) provided along the laser optical axis direction either in the vicinity of or in contact with the dielectric pipes (5a, 5b) or pipe (5) are arranged as:

a) a plurality of corona starting electrodes spaced from each other around the circumference of each of said pipes or pipe on a cross-section perpendicular with the laser optical axis by a given pitch, or
b) one corona starting electrode (8) is wound in a spiral around each of said pipes or pipe whereby said spiral has a given pitch in the laser optical axis direction, or
c) one corona starting electrode (8) is provided along the laser optical axis direction in the vicinity of or in contact with each of said pipes or pipe,

such that in cases a) and b) a length of half of the pitch is denoted by ℓ and in the case c) above, a length of half of the outer circumferential length of the dielectric material pipes (5a, 5b) or pipe (5) along said perpendicular cross-section is denoted also by ℓ,
a first direction (10) being defined by a straight line perpendicular to the laser optical axis connecting a center point (9) on the surface of the first main electrode (1) facing the second main electrode (2) and the corona discharge starting point (7c) nearest to the first main electrode (1) at which a corona starting electrode (8b) starts corona discharge (6c), and
a second direction (11) being defined by the straight line of the intersection of a plane perpendicular to the direction of the corona discharge development at the corona discharge starting point nearest to the first main electrode (1) and a plane perpendicular to the laser oscillation optical axis, wherein an angle θ is produced between the first (10) and second (11) directions, whereby when

$$\theta = 0 \text{ to } 72.5°$$

the measure of the strength of preionization is given as $I = \ell \times \cos\theta$ and when

$$\theta = 72.5° \text{ or more}$$

the measure of strength of preionization is given as $I = \ell \times 0.3$, and
wherein in the case that the dielectric material (5a, 5b) is disposed on both sides of the second main electrode (2), I = 3mm or more, whereas in the case that the dielectric material (5) is disposed on one side of the second main electrode (2), I = 6mm or more.

2. A transverse discharge excitation pulse laser oscillator apparatus stated in claim 1 and characterized in that, in the case that the dielectric material (5a, 5b) is disposed on both sides of the second main electrode (2), the measure of the strength of the preionization I is, I = 5mm or more, whereas in the case that the dielectric material is disposed on one side of the second main electrode (2), I = 10mm or more.

3. A transverse discharge excitation pulse laser oscillator apparatus stated in claim 1 and claim 2 and characterized in that, denoting the minimum gap length between the first main electrode (1) and the second main electrode (2) by a notation g, the minimum separation distance (L) between the first main electrode (1) and the dielectric material (5; 5a, 5b) is taken to be 1.05 times or more and 1.5 times or less of said minimum gap length g.

4. A transverse discharge excitation pulse laser oscillator apparatus stated from claim 1 to claim 3 and characterized in that said dielectric material pipes (5a, 5b) are disposed in such a manner as they are buried in the second main electrode (2) and at the same time the dielectric pipes (5a, 5b) are disposed in a manner that they keep a certain distance d from the second main electrode (2) with the exception of proximity or contact with the second main electrode (2) or with the corona starting electrodes at some parts (13a, 13b), and in addition to that, the distance d is more than the thickness of the dielectric material of the pipes (5; 5a, 5b).

5. A transverse discharge excitation pulse laser oscillator apparatus stated from claim 1 to claim 4 and characterized in that said dielectric material pipes (5; 5a, 5b) are made of alumina ceramics composed of alumina as its main composition, and said laser is an excimer laser.

6. A transverse discharge excitation pulse laser oscillator apparatus stated from claim 1 to claim 5 and characterized in that said dielectric material pipe (5; 5a, 5b) is a square-shaped pipe.

7. A transverse discharge excitation pulse laser oscillator apparatus stated from claim 1 to claim 5 and characterized in that the corona starting electrode (8) is wound spirally on the surface of the dielectric material pipe (5).

Patentansprüche

1. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung, die eine erste (1) und eine zweite (2) Hauptelektrode aufweist, die angeordnet sind, um einander über eine bestimmte Länge in der Richtung der optischen Achse des Lasers zugewandt zu sein, wobei die Vorrichtung folgendes aufweist:
   hohle Röhren (5a, 5b) oder eine hohle Röhre (5) aus dielektrischem Material, die in der Richtung der optischen Achse des Lasers verlaufen/verläuft und auf beiden Seiten oder auf einer Seite der zweiten Hauptelektrode (2) unter Einhaltung eines Abstands (d) davon angeordnet sind/ist,
   Hilfselektroden (4a, 4b) oder eine Hilfselektrode (4), die im Inneren jeder der Röhren oder der Röhre aus dielektrischem Material angeordnet sind,
   Koronastartelektroden (8a, 8b, 8c, 8d) oder eine Koronastartelektrode (8), die in der Nähe von oder in Kontakt mit den Röhren (5a, 5b) oder der Röhre (5) aus dielektrischem Material vorgesehen und fakultativ als ein integraler Teil der zweiten Hauptelektrode (2) vorgesehen sind/ist, wobei das Potential der Koronastartelektroden gleich demjenigen der zweiten Hauptelektrode (2) gehalten wird,
   wobei Koronaentladungen (6a, 6b, 6c, 6d) von den Koronastartelektroden (8a, 8b, 8c, 8d) oder der -elektrode (8) ausgehen und sich über der Oberfläche der Röhren (5a, 5b) oder der Röhre (5) aus dielektrischem Material entwickeln und ausbreiten durch Anlegen einer Spannung über die Hauptelektrode (2) sowie die Koronastartelektroden (8a, 8b, 8c, 8d) oder die -elektrode (8) und die Hilfselektroden (4a, 4b) oder die -elektrode (4),
   wobei Lasergas, das zwischen der ersten und der zweiten Hauptelektrode (1, 2) anwesend ist, von der durch die Koronaentladungen (6a, 6b, 6c, 6d) erzeugten UV-Strahlung präionisiert wird, was eine gleichmäßige Hauptentladung (3) in dem Raum zwischen der ersten und der zweiten Hauptelektrode (1, 2) erlaubt, um das Lasergas anzuregen,
   wobei die Koronastartelektroden (8a, 8b, 8c, 8d) oder die -elektrode (8), die entlang der Richtung der optischen Achse des Lasers entweder in der Nähe der oder in Kontakt mit den dielektrischen Röhren (5a, 5b) oder der Röhre (5) vorgesehen sind/ist, angeordnet sind/ist als:
   a) eine Vielzahl von Koronastartelektroden, die voneinander um den Umfang jeder der Röhren oder der Röhre auf einem Querschnitt senkrecht zu der optischen Achse des Lasers um eine gegebene Teilung beabstandet sind, oder
   b) eine Koronastartelektrode (8) ist spiralförmig um jede der Röhren oder die Röhre gewickelt, wobei die Spirale in der Richtung der optischen Achse des Lasers eine gegebene Teilung hat, oder
   c) eine Koronastartelektrode (8) ist entlang der Richtung der optischen Achse des Lasers in der Nähe von oder in Kontakt mit jeder der Röhren oder der Röhre vorgesehen,
   so daß in den Fällen a) und b) eine der halben Länge entsprechende Teilung mit 1 bezeichnet ist und im obigen Fall c) eine der halben Außenumfangslänge der Röhren (5a, 5b) oder der Röhre (5) aus dielektrischem Material entsprechende Länge entlang dem senkrechten Querschnitt ebenfalls mit 1 bezeichnet ist,
   wobei eine erste Richtung (10) durch eine Gerade definiert ist, die zu der optischen Achse des Lasers senkrecht ist und einen Mittelpunkt (9) auf der der zweiten Hauptelektrode (2) zugewandten Oberfläche der ersten Hauptelektrode (1) und den Koronaentladungs-Startpunkt (7c) verbindet, der der ersten Hauptelektrode (1) am nächsten ist und an dem eine Koronastartelektrode (8b) die Koronaentladung (6c) startet, und eine zweite Richtung (11) definiert ist durch die Gerade des Schnittpunkts einer Ebene, die zu der Richtung der Koronaentladungsausbildung an dem Koronaentladungs-Startpunkt nächst der ersten Hauptelektrode (1) senkrecht ist, und einer Ebene, die zu der optischen Achse der Laserschwingung senkrecht ist,
   wobei ein Winkel θ zwischen der ersten (10) und der zweiten (11) Richtung gebildet wird, so daß, wenn

   $$\theta = 0 \text{ bis } 72{,}5°$$

   das Maß der Stärke der Präionisation gegeben ist als $I = l \times \cos\theta$, und wenn

   $$\theta = 72{,}5° \text{ oder größer}$$

   das Maß der Stärke der Präionisation gegeben ist als $I = 1 \times 0{,}3$, und
   wobei in dem Fall, daß das dielektrische Material (5a, 5b) an beiden Seiten der zweiten Hauptelektrode (2) angeordnet ist, I = 3 mm oder mehr, wohingegen in dem Fall, daß das dielektrische Material (5) an einer Seite der zweiten Hauptelektrode (2) angeordnet ist, I = 6 mm oder mehr.

2. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung nach Anspruch 1, dadurch gekennzeichnet, daß in dem Fall, daß das dielektrische Material (5a, 5b) an beiden Seiten der zweiten Hauptelektrode (2) angeordnet ist, das Maß der Stärke der Präionisation I = 5 mm oder mehr, wohingegen in dem Fall, daß das dielektrische Material an einer Seite der zweiten Hauptelektrode (2) angeordnet ist, I = 10 mm oder mehr.

3. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung nach Anspruch 1 und Anspruch 2, dadurch gekennzeichnet, daß, wenn die kleinste Zwischenraumlänge zwischen der ersten Hauptelektrode (1) und der zweiten Hauptelektrode (2) mit g bezeichnet ist, die kleinste Trennungsstrecke (L) zwischen der ersten Hauptelektrode (1) und dem dielektrischen Material (5; 5a, 5b) als das 1,05fache oder mehr und das 1,5fache oder weniger der kleinsten Zwischenraumlänge g angenommen wird.

4. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung nach Anspruch 1 bis Anspruch 3, dadurch gekennzeichnet, daß die Röhren (5a, 5b) aus dielektrischem Material auf solche Weise angeordnet sind, daß sie in der zweiten Hauptelektrode (2) vergraben sind, und daß gleichzeitig die dielektrischen Röhren (5a, 5b) auf solche Weise angeordnet sind, daß sie einen bestimmten Abstand d von der zweiten Hauptelektrode (2) beibehalten mit der Ausnahme der Nähe zu oder des Kontakts mit der zweiten Hauptelektrode (2) oder den Koronastartelektroden an einigen Teilen (13a, 13b), und daß außerdem der Abstand d größer als die Dicke des dielektrischen Materials der Röhren (5; 5a, 5b) ist.

5. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung nach Anspruch 1 bis Anspruch 4, dadurch gekennzeichnet, daß die Röhren (5; 5a, 5b) aus Aluminiumoxid-Keramik hergestellt sind, die aus Aluminiumoxid als ihrer Hauptzusammensetzung besteht, und daß der Laser ein Excimerlaser ist.

6. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung nach Anspruch 1 bis Anspruch 5, dadurch gekennzeichnet, daß die Röhre (5; 5a, 5b) aus dielektrischem Material eine Röhre mit Viereckgestalt ist.

7. Gepulste Lasergeneratorvorrichtung mit Querentladungsanregung nach Anspruch 1 bis Anspruch 5, dadurch gekennzeichnet, daß die Koronastartelektrode (8) spiralförmig auf die Oberfläche der Röhre (5) aus dielektrischem Material gewickelt ist.

Revendications

1. Dispositif oscillateur laser pulsé d'excitation à décharge transversale pourvu de première (1) et seconde (2) électrodes principales qui sont disposées en se faisant face l'une à l'autre sur une longueur spécifiée dans la direction d'axe optique du laser, le dispositif comprenant :

des tubes (5a, 5b) ou un tube (5) creux en matériau diélectrique s'étendant dans la direction de l'axe optique du laser et étant disposé(s) aux deux côtés ou d'un côté de la seconde électrode principale (2) tout en gardant une distance (d) de celle-ci,

des électrodes (4a, 4b) ou une électrode (4) auxiliaire(s) disposée(s) à l'intérieur de chacun des tubes ou du tube en matériau diélectrique,

des électrodes (8a, 8b, 8c, 8d) ou une électrode (8) de démarrage d'effet corona prévue(s) au voisinage de ou en contact avec les tubes (5a, 5b) ou le tube (5) en matériau diélectrique et optionnellement prévue(s) en une partie intégrale de la seconde électrode principale (2), le potentiel des électrodes de démarrage d'effet corona étant conservé le même que celui de la seconde électrode principale (2),

dans lequel des décharges corona (6a, 6b, 6c, 6d) démarrent des électrodes (8a, 8b, 8c, 8d) ou de l'électrode (8) de démarrage d'effet corona et se développent et s'étendent sur la surface des tubes (5a,5b) ou de tube (5) en matériau diélectrique en appliquant une tension à travers l'électrode principale (2) ainsi que les électrodes (8a, 8b, 8c, 8d) ou l'électrode (8) de démarrage d'effet corona et les électrodes (4a, 4b) ou l'électrode (4) auxiliaire(s),

dans lequel le gaz laser existant entre des première et seconde électrodes principales (1, 2) est préionisé par le rayonnement ultraviolet produit par les décharges corona (6a, 6b, 6c, 6d) permettant ainsi une décharge principale uniforme (3) dans l'espace entre les première et seconde électrodes principales (1, 2) pour exciter le gaz laser,

dans lequel les électrodes (8a, 8b, 8c, 8d) ou l'électrode (8) de démarrage d'effet corona prévue(s) le long de la direction de l'axe optique du laser, soit au voisinage de ou en contact avec les tubes (5a, 5b) ou le tube (5) diélectrique(s), sont agencées en :

a) un certain nombre d'électrodes de démarrage d'effet corona espacées les unes des autres autour de la circonférence de chacun des tubes ou du tube sur une coupe perpendiculaire à l'axe optique du laser d'un pas donné, ou

b) une électrode de démarrage d'effet corona (8) est enroulée en une spirale autour de chacun des tubes ou du tube, de la sorte ladite spirale a un pas donné dans la direction de l'axe optique du laser, ou

c) une électrode de démarrage d'effet corona (8) est prévue le long de la direction de l'axe optique du laser au voisinage de ou en contact avec chacun des tubes ou le tube,

de sorte qu'aux cas a) et b) une longueur de moi-

tié du pas est désignée par ℓ et qu'au cas c) ci-dessus, une longueur de moitié de la longueur circonférentielle externe des tubes (5a, 5b) ou du tube (5) en matériau diélectrique le long de la coupe perpendiculaire est également désignée par ℓ,

une première direction (10) étant définie par une ligne droite perpendiculaire à l'axe optique du laser en reliant un point central (9) sur la surface de la première électrode principale (1) faisant face à la seconde électrode principale (2) et le point de démarrage de décharge corona (7c) le plus proche de la première électrode principale (1) à laquelle une électrode de démarrage d'effet corona (8b) démarre la décharge corona (6c), et

une seconde direction (11) étant définie par la ligne droite de l'intersection d'un plan perpendiculaire à la direction de la production de décharge corona au point de démarrage de décharge corona le plus proche de la première électrode principale (1) et un plan perpendiculaire à l'axe optique d'oscillation laser,

dans lequel un angle θ est produit entre les première (10) et seconde (11) directions, de la sorte lorsque

$$\theta = 0 \text{ à } 72{,}5°$$

la mesure de la force de préionisation est donnée comme $l = \ell \times \cos\theta$ et lorsque

$$\theta = 72{,}5° \text{ ou plus}$$

la mesure de force de préionisation est donnée en $l = \ell \times 0{,}3$, et

dans lequel dans le cas où le matériau diélectrique (5a, 5b) est disposé aux deux côtés de la seconde électrode principale (2), l = 3mm ou plus, tandis que dans le cas où le matériau diélectrique (5) est disposé sur un côté de la seconde électrode principale (2), l = 6mm ou plus.

2. Dispositif oscillateur laser pulsé d'excitation par décharge transversale défini en revendication 1 et caractérisé en ce que, dans le cas où le matériau diélectrique (5a, 5b) est disposé aux deux côtés de la seconde électrode principale (2), la mesure de la force de préionisation l est, l = 5mm ou plus, tandis que dans le cas où le matériau diélectrique est disposé sur un côté de la seconde électrode principale (2), l = 10mm ou plus.

3. Dispositif oscillateur laser pulsé d'excitation par décharge transversale défini en revendication 1 ou en revendication 2 et caractérisé en ce que, en désignant la longueur d'intervalle minimum entre la première électrode principale (1) et la seconde électrode principale (2) par une notation g, la distance de séparation minimum (L) entre la première électrode principale (1) et le matériau diélectrique (5; 5a, 5b) est prise pour être de 1,05 fois ou plus et 1,5 fois ou moins de ladite longueur d'intervalle minimum g.

4. Dispositif oscillateur laser pulsé d'excitation par décharge transversale définie de la revendication 1 à la revendication 3 et caractérisé en ce que des tubes en matériau diélectrique précités (5a, 5b) sont disposés de telle manière qu'ils sont enfouis dans la seconde électrode principale (2) et en même temps les tubes diélectriques (5a, 5b) sont disposés d'une manière qu'ils gardent une certaine distance d de la seconde électrode principale (2) à l'exception de la proximité ou du contact avec la seconde électrode principale (2) ou avec les électrodes de démarrage d'effet corona à certaines parties (13a, 13b), et en plus de cela, la distance d est supérieure à l'épaisseur du matériau diélectrique des tubes (5; 5a, 5b).

5. Dispositif oscillateur laser pulsé d'excitation par décharge transversale défini de la revendication 1 à la revendication 4 et caractérisé en ce que les tubes en matériau diélectrique précités (5; 5a, 5b) sont réalisés en céramiques d'alumine composées d'alumine comme composant principal, et le laser est un laser d'excitation.

6. Dispositif oscillateur laser pulsé d'excitation par décharge transversale défini de la revendication 1 à la revendication 5 et caractérisé en ce que le tube en matériau diélectrique précité (5; 5a, 5b) est un tube de forme carrée.

7. Dispositif oscillateur laser pulsé d'excitation par décharge transversale défini dans la revendication 1 à la revendication 5 et caractérisé en ce que l'électrode de démarrage d'effet corona (8) est enroulée en spirale sur la surface du tube en matériau diélectrique (5).

FIG.1

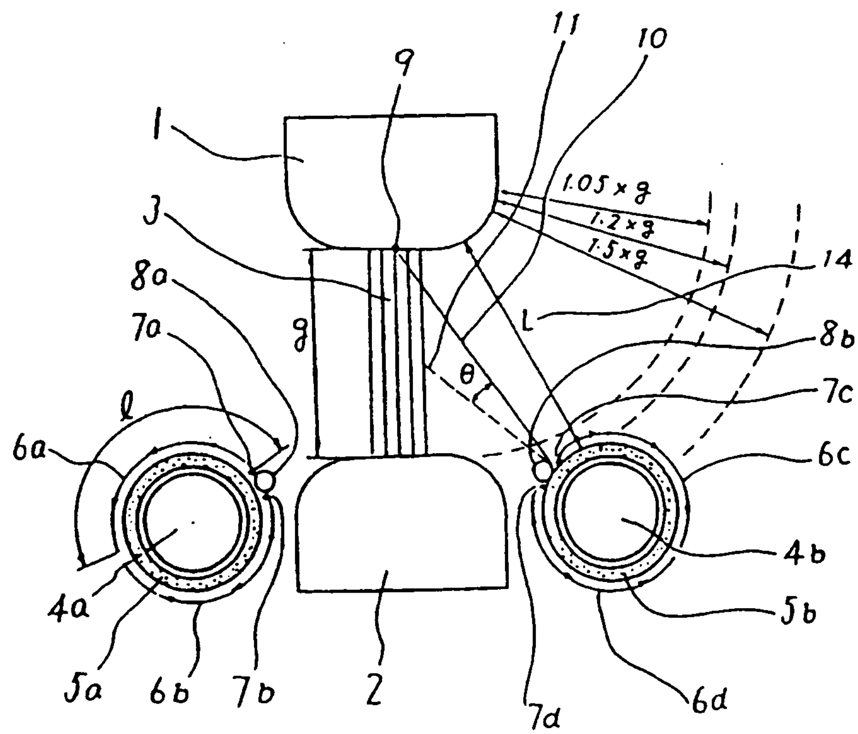
1
2
3
4a
4b
5a
5b
6a
6b
6c
6d
7a
7b
7c
7d
8a
8b
9
10
11
14
g
ℓ
L
θ
1.05×g
1.2×g
1.5×g

FIG.2

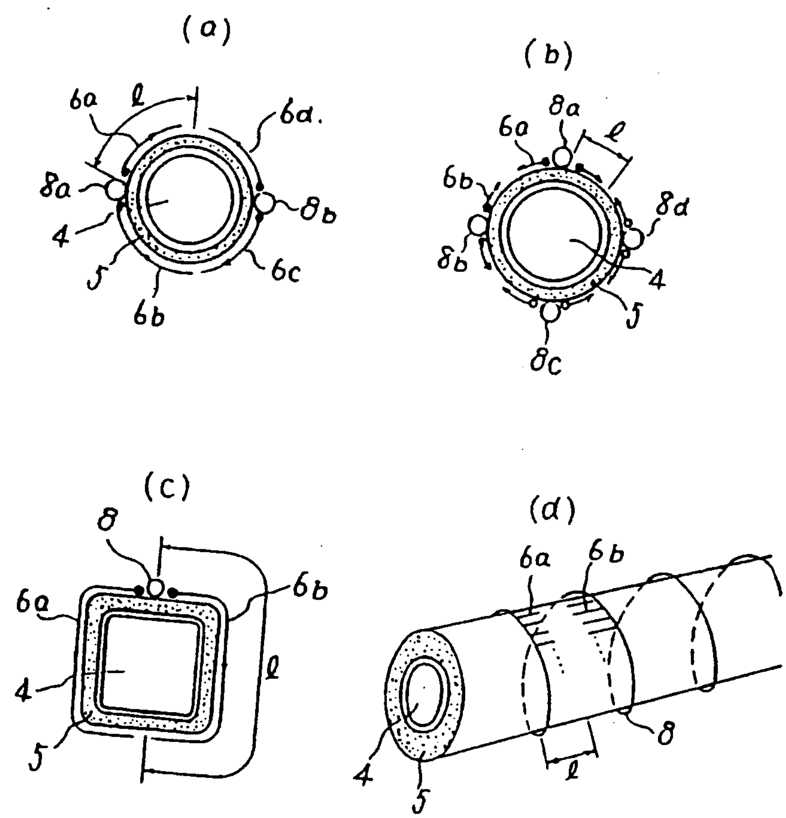
(a)
6a
ℓ
6a.
8a
8b
4
5
6c
6b
(b)
8a
6a
ℓ
6b
8d
8b
4
5
8c
(c)
8
6a
6b
4
ℓ
5
(d)
6a
6b
8
4
5
ℓ

FIG.3

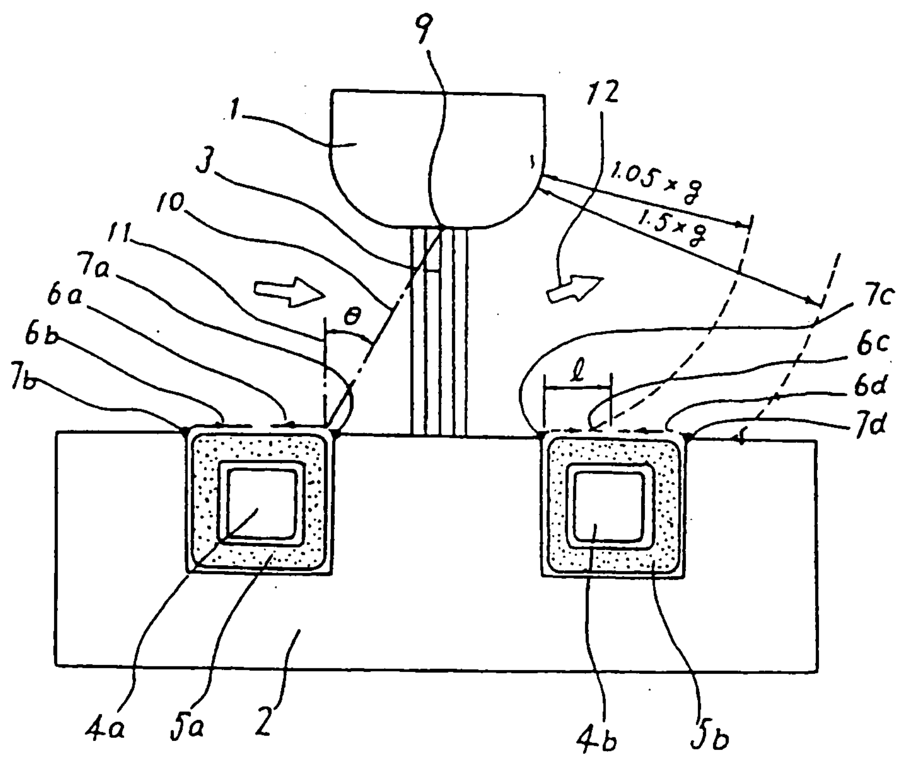

FIG.4

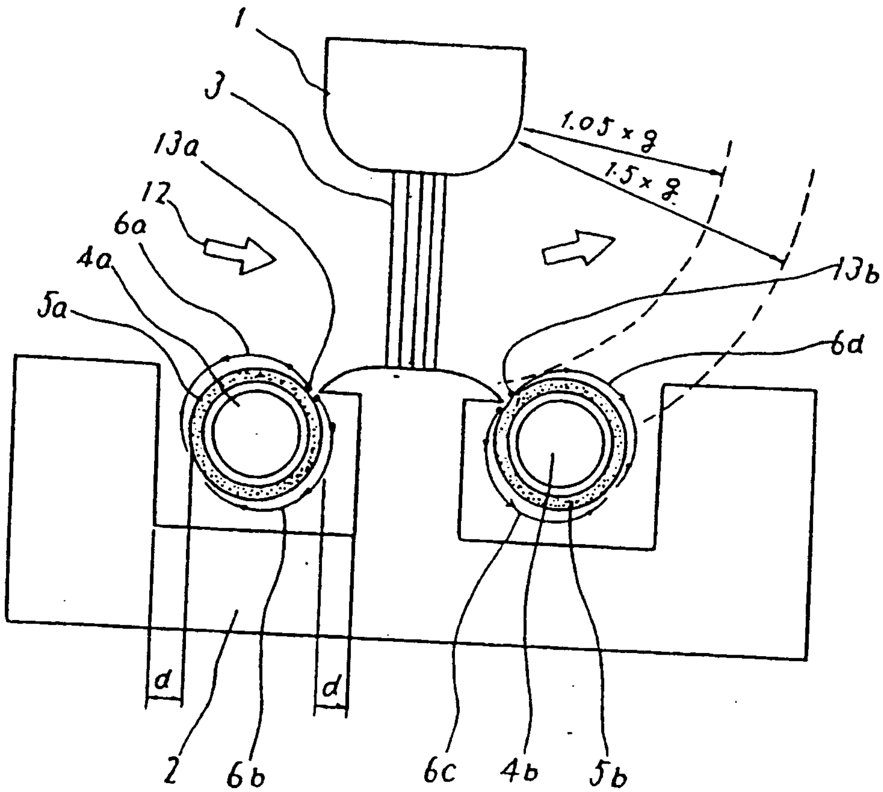

FIG.5